Technology Demonstration Fact Sheet
Wireless Remote Radiation Monitoring System

SUMMARY

During September and October of 1997, the C Reactor Technology Demonstration Group demonstrated the RadStar, a wireless remote radiation monitoring system that was developed by Science Applications International Corporation (SAIC). The Radiological Control Group at C Reactor used the RadStar system to monitor personnel dose and area exposure rate remotely from a predetermined command center away from radioactively contaminated areas. The demonstration took place in various locations at C Reactor area while personnel performed their daily routine decontamination and decommissioning (D&D) activities. The RadStar System provides a remotely monitored real-time read-out and was compared to our baseline technology of a pencil dosimeter (a self reading dosimeter [SRD] made with a small calibrated ion chamber) issued to personnel going into radiation areas. The system also is used to monitor radioactivity in a room or area.

Results of using the system proved to be very useful from a radiological health and control viewpoint. The system provides supervisors the ability to observe the real-time area exposure rate and personnel dose. This provides information to adjust the workers' stay time due to dose limitation, which could result in a productivity increase or improve protection against excessive dose.

Alarm set points on each dosimeter and the alarming system at the RadStar base station were demonstrated and the system alarmed as expected at the preset alarm set points.

INNOVATIVE TECHNOLOGY DESCRIPTION

The innovative technology system provides a real-time monitoring data read-out feature. Current baseline technologies, such as pencil dosimeter or other complementary dosimeters issued to the personnel performing tasks in a radiation area do not allow anyone to evaluate a worker's real-time dose and area exposure rate. Thus, personnel must continuously be aware of the conditions and check their dosimeters. This is further complicated when employees are wearing more than one set of anti-contamination coveralls, a respirator, and extra gloves and performing a conventional task in areas where light intensity is not adequate for reading dosimeters to infer the accumulated dose. The RadStar wireless remote radiation monitoring system consists of:

A host personal computer that monitors and records the information transmitted from the electronic dosimeters and collected by the radiotransceiver base using RadStar software.

Model PD-4 radio transceiving alarming electronic dosimeters, each contained in a small plastic case with wireless radio components, radiation detector, and a nine-volt alkaline battery, which are worn by the personnel.

A model PDX-4 transceiver base station, which is connected to the computer and receives the data and information from each dosimeter remotely and feeds them to the computer.

A model PDR-1 dosimeter reader, which is connected to the computer via a RS-232 connection, reads the dosimeters and resets them after use.

The wearable monitor weighs less than 400 g (0.9 lbs). Presently it is designed to detect gamma radiation. The detector in this electronic dosimeter is an energy-compensated GM tube, which has a range of 10 mR to 999 R cumulative dose. Each electronic dosimeter on this system can be preset to alarm at an alarm set point. The unit has been designed to accommodate (in near future) an additional detector to measure beta dose and exposure rate.

As many as sixty-four workers can be monitored simultaneously by the base station. In normal operation mode, every 10 seconds a signal from each dosimeter is received, processed, and recorded by the RadStar software on the computer. The information from one individual is automatically updated and recorded by the computer in an appropriate dosimeter file. If a person's dosimeter exceeds the alarm set point dose, the system will automatically activate a light-emitting diode or an audible alarm (~100 db) warning both the person and the base station.

In addition, the person manning the supervisory station can manually alarm another person working in the radiation area. After receiving the warning, the worker can withdraw from the work area and consult with the supervisor. Another key innovation of this monitoring system is its wireless capability utilizing spread spectrum technology. Straight-line signals can be transmitted over 10,000 feet. The system meets the requirements of Federal Communications Commission Part 15 and requires no licensing. The electronic dosimeters, PD-4's, are battery operated and the 9-volt battery used operates the dosimeter for 8 continuous hours in a 10 mR/h field transmitting every 10 seconds. Downloading and manipulating the collected data requires basic computer skills.

BASELINE TECHNOLOGY DESCRIPTION

The baseline technologies used were SRDs. Each SRD is comprised of a small, calibrated ion chamber which has a reading scale on one end that indicates the amount of dose accumulated. These dosimeters are commonly referred to as pocket dosimeters or pencil dosimeters.

To read the scale on these dosimeters, one has to direct the opposite end of the dosimeter from the reader end to a source of light and carefully read the scale. Using these dosimeters when work is being performed in areas that require more than one set of protective coveralls, a respirator, and extra gloves makes the reading and handling of these dosimeters more difficult. These SRDs do not directly indicate exposure rate or perform any alarm functions.

DEMONSTRATION DESCRIPTION

This demonstration consisted of a vendor representative giving on-the-job instruction to radiological control personnel in the set up and proper use of this system. Once the instruction was completed and the personnel were comfortable with the

operation of the RadStar system, a series of measurements was conducted while personnel performing their daily tasks were being monitored by RadStar. The demonstration was conducted over a period of 2 months at various locations at C Reactor during a variety of D&D activities.

The innovative system transmission range was assessed by keeping the base station at a fixed location outside of the C Reactor area and moving the electronic dosimeters (PD-4) within the reactor building from area to area. This test indicated that the transmission was very good within 200 feet line of sight. But when the line of sight between the base station and PD-4's was obstructed by solid concrete walls or other structures with height greater than 15 feet, the transmission did not perform as well as clear open line of sight, and the signal was often lost. (This could be improved by use of stationary antennae.) Dosimeters were used as transmission repeaters to alleviate this problem. The calibrated PD-4's and SRD's were worn by the personnel and also were located in different areas within the C Reactor area side by side to check the response of the innovative dosimeters against the baseline dosimeter. Results of these tests are presented below:

Dosimeter No.	Location at C Reactor	SRD Resp. (mrem)	PD-4 Resp. (mrem)
28	Fuel Storage Basin	85	102
36	Outer Rod Room	0	0.7
43	Outer Rod Room	0	0.1
33	Outer Rod Room	0	0.1
44	Outer Rod Room	0	0.2
28	Outer Rod Room	0	0.1
43	Transfer Pit	60	51.3
36	Transfer Pit	80	61.4
43	Inner Rod Room	0	5.0
28	Inner Rod Room	0	3.5
33	Inner Rod Room	0	4.4
36	Inner Rod Room	0	2.1
30	Inner Rod Room	0	8.0

Field data collected during this demonstration indicate that the innovative system has better sensitivity than the baseline dosimeters, but generally they have similar response in higher dose situations.

DETAILS OF BENEFITS

Provides real-time dose and exposure rate monitoring and logs the data automatically in the computer database for future use, thus helping prevent potentially excessive exposures.

Features preset alarm levels for each of the real-time monitoring dosimeters PD-4s.

Dosimeters can act as repeaters for remote areas or where structural obstructions exist.

The system can monitor up to 10 individual employees with a different alarm set point for each individual independent of the others.

The system avoids the need to bring a potentially contaminated glove or SRD into close proximity to the worker's face.

SUCCESS CRITERIA

During the demonstration, alarms were set off as expected at the pre-set values.

Area exposure rates and personnel doses were remotely monitored successfully.

The exposure rates and the dose values reported by this system all were within the acceptable range for accuracy and repeatability.

The system could communicate from inside the Reactor to the outside base station within a range of 200 feet.

SCHEDULE

The RadStar was demonstrated onsite for two months. Sixteen employees were monitored during this demonstration during various D&D activities. Setup steps included setting up the lap-top computer, turning on the RadStar packs, establishing contact with the computer, and donning employees with the monitoring probes and dosimeter packs. The average setup time was approximately 20 minutes.

In addition to the above monitoring events, the system will be deployed during all high-dose D&D activities at C Reactor during the period of November 1997 to July 1998.

FUTURE APPLICABILITY

The use of real-time dose and exposure rate monitoring will improve the ALARA concept on any job site where the personnel are exposed to elevated radiation area indoors or outdoors. This system should be considered when a job or a task is expected to include high-exposure activities to protect additional employees from high exposure to radiation.

Work areas to consider are radiological waste sites, production reactors at Hanford and other DOE sites, canyons, hot cell clean up, power industry, etc. where the probability of high exposure to personnel exists.

CONTACT PERSONS

John Duda, FETC, (304) 285-4217
Shannon Saget, DOE-RL, (509) 372-4029
Jeff Bruggeman, DOE-RL, (509) 376-7121
Stephen Pulsford, BHI, (509) 372-9683
Matt Rackstein, SAIC, (619) 646-9135